The Marshall Grazing Incidence X-ray Spectrometer (MaGIXS)

[1,2]Patrick Champey, [2]Amy Winebarger, [2]Ken Kobayashi, [2]Sabrina Savage, [2]Jonathan Cirtain, [3]Peter Cheimets, [3]Edward Hertz, [3]Leon Golub, [2]Brian Ramsey, [2]Jeff McCracken, [4]Ralf Heilmann, [4]Mark Schattenburg, [5]Alexander Bruccoleri

[1]University of Alabama in Huntsville, [2]NASA Marshall Space Flight Center, [3]Smithsonian Astrophysical Observatory, [4]Massachusetts Institute of Technology, [5]Izentis LLC

Experiment Background

The Marshall Grazing Incidence X-ray Spectrometer (MaGIXS) is a NASA sounding rocket instrument designed to observe soft X-ray emissions from 0.5 - 2.0 keV energies in the solar atmosphere. The primary science goal is to differentiate steady, low-frequency heating events from sporadic, high-frequency heating events in the active region core. For the first time, high-temperature, low-emission plasma will be observed directly with 5 arcsecond spatial and 22 mÅ spectral resolution. The novel optical design consists of a Wolter-I telescope and a 3-optic grazing-incidence spectrograph. Mandrel fabrication and nickel replication will be done at MSFC. Mounting and alignment of the flight optics will be performed at the Smithsonian Astrophysical Observatory (SAO).

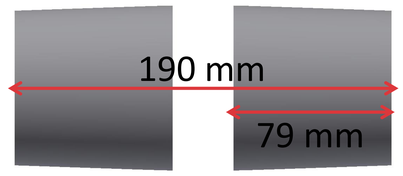
Spectrometer Specs.

- Passband: 6.0 – 24.0 Å (2.0 – 0.5 keV)
- Spectral resolution: 22 m Å
- Spatial resolution: 5’’
- Spectral plate scale: 11 mÅ/pixel
- Spatial plate scale: 2.8’’/pixels
- Off-axis spot size: < 5 µm RMS radius

Spectrometer Mirrors

- Finite conjugate paraboloid pair
- Nickel replicated mirror shell
- Iridium coated
- Focal length: 597 mm
- r_{max}: 41.91 mm r_{min}: 39.21 mm
- Segment length: 79 mm

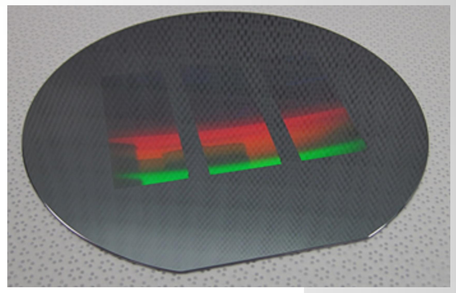
Like the telescope mirror, the spectrometer mirrors will be fabricated by MSFC using nickel replication. The spectrometer mirrors carry tight alignment tolerances, with respect to each other.



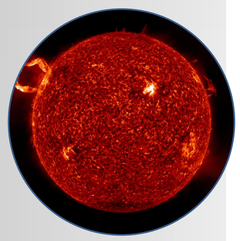
Grating

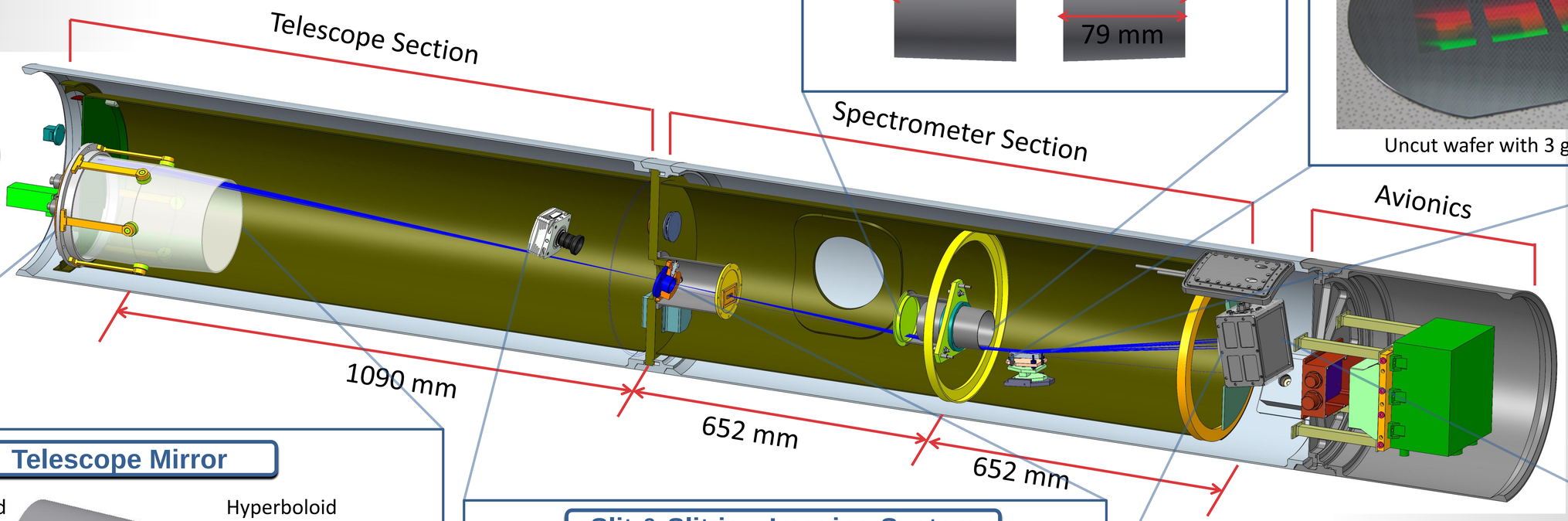
- Type: Blazed planar varied line space
- Material: Nanoimprinted on fused silica
- Gold coated
- Size: 64 x 25 mm (tangential x sagittal)
- Blaze angle: 1.6°
- Ruling: 2146-2709 lines/mm

The gratings will be fabricated by MIT and Izentis LLC using nanoimprinting and anisotropic etching techniques.

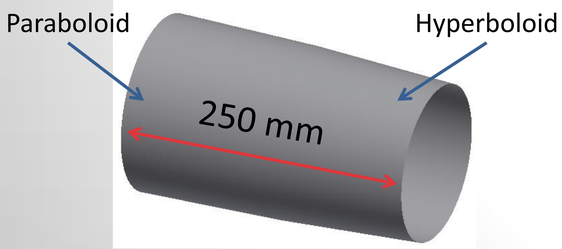


Uncut wafer with 3 gratings





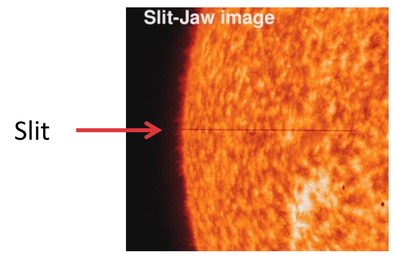
Telescope Mirror



- Wolter-I paraboloid-hyperboloid combination
- Single nickel replicated mirror shell
- Iridium coated
- Focal length: 1090 mm
- Graze angle: 0.957°
- r_{max}: 75.12 mm r_{min}: 66.75 mm
- A_{geo} (34° sector) : 87 mm^2
- Segment length: 125 mm
- 0.5 nm surface roughness

The telescope mirror will be fabricated by MSFC using the same techniques that were used for ART-XC and FOXSI mirrors. The mandrel will be coated with electroless nickel and diamond turned before being polished into figure. Several mirror shells will be fabricated and their performance verified at the Stray Light Facility (SLF). The best performing mirror will be selected as the flight optic.

Slit & Slit-jaw Imaging System



Example slit-jaw image (actual image from the CLASP experiment)

Slit

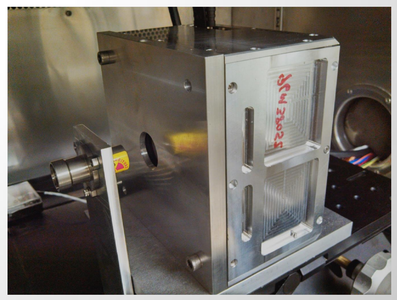
- Solid aluminum machined slit
- Width x Length: 15 µm x 2.6 mm (2.5’’ x 8.0’)
- Slit surface coated with Lumogen (phosphor coating)

Slit-jaw Imaging System

- Commercial off-the-shelf detector and lens
- 512 x 512 CCD
- Pixel size: 15 µm (2.5’’)
- FOV: 21’

The slitjaw imaging system is required for pointing during flight and is used as a context imager for coalignment with other observatories and instruments. The slitjaw system is also used to align the experiment to the sun sensors used by the SPARCS system.

Science Camera



Engineering model of the CLASP camera

- 2k x 2k back-illuminated CCD
- Frame transfer (2k x 1k image size)
- Pixel size: 15 µm
- Read noise: ~ 5 e-
- Dark current : < 1 e-/pix/sec

The MaGIXS camera will be the same design as the Hi-C 2 flight camera. The Hi-C 2 camera design is based on the CLASP cameras that flew on September 3, 2015. These cameras are designed, assembled and tested in-house at MSFC.